PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04B 7/26

A1

(11) International Publication Number: WO 99/12284

(43) International Publication Date: 11 March 1999 (11.03.99)

(21) International Application Number: PCT/SE98/01541

(22) International Filing Date: 28 August 1998 (28.08.98)

(30) Priority Data:
9703161-1 2 September 1997 (02.09.97) SE

(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventor: DAHLMAN, Erik; Tackjärnsvägen 12, S-168 68 Bromma (SE).

(74) Agent: ERICSSON RADIO SYSTEMS AB; Common Patent Dept., S-164 80 Stockholm (SE).

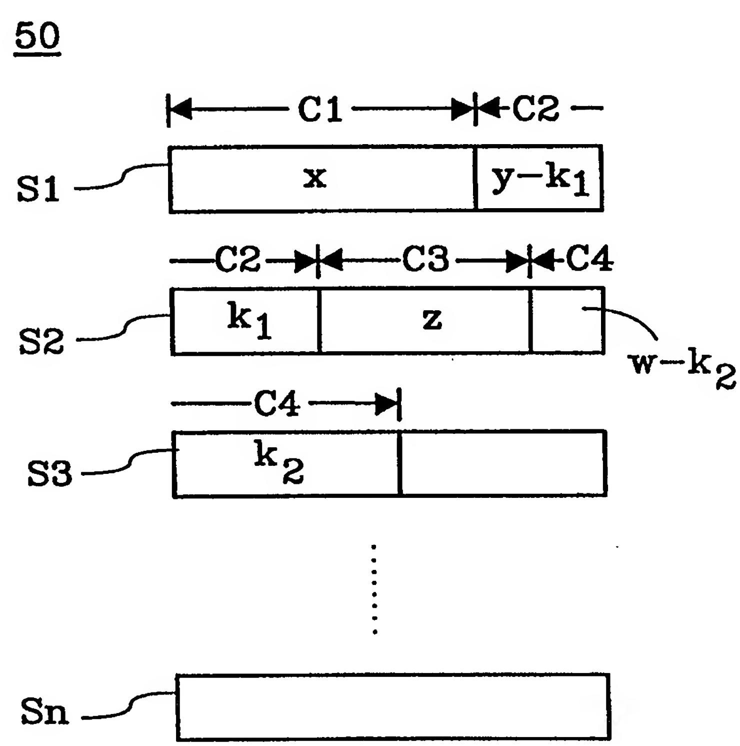
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A METHOD FOR ASSIGNING SPREADING CODES

(57) Abstract

The present invention relates to methods for assigning spreading codes to forward-link connections with variable bit-rate in DS-CDMA communication systems. A first connection is assigned a first number of codes (x) from a first set (S1) of orthogonal codes. A second connection is assigned a second number of codes (y). A first part ($y-k_1$) of the second number of codes (y) is taken from the first set (S1) of orthogonal codes. A second part (k_1) of the second number of codes (y) is taken from a second set (S2) of orthogonal codes which is non-orthogonal to the first set (S1).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

A METHOD FOR ASSIGNING SPREADING CODES

TECHNICAL FIELD OF THE INVENTION

The present invention relates to methods for assigning spreading codes to DS-CDMA forward-link connections.

DESCRIPTION OF RELATED ART

CDMA (Code Division Multiple Access) is a well known method for multiple access in a radio communication system. The CDMA method uses the spread spectrum technique in which a number of users simultaneously occupy the same frequency band with their radio channels.

In a DS-CDMA (Direct Sequence-CDMA) system which is a particular type of the CDMA techniques, each user is assigned a specific spreading code by which the user is separated from the other users of the system. Another name for a spreading code is spreading sequence or spreading-code sequence.

The transmitted information in the radio signal is coded (spread) by a specific spreading code in the transmitter. At the receiving end the coded information is decoded (despread) by correlating with the same specific spreading code again or by filtering the received information in a matched filter.

A spreading code of the same length as the symbol interval is called a short spreading code.

Orthogonal codes are codes that has zero cross correlation for zero time offset. The use of orthogonal codes will reduce the intra-cell interference, i.e. interference from other forward-link signals in the same cell. Normally the intra-cell

interference will not be completely eliminated as time dispersion will partly destroy the orthogonality between signals coded with orthogonal codes.

In general, a set of orthogonal codes does only contain a finite number of codes, where the number of codes is always smaller or the same as the length of the codes.
Consequently, as there are only a finite number of orthogonal spreading codes available, spreading codes which are almost orthogonal or non-orthogonal has to be used to increase the number of simultaneous users or increase the bit-rate of the system.

On a DS-CDMA forward-link (transmission from a base station to a radio unit), orthogonal spreading codes are often used to separate different radio channels.

When a connection through a radio channel uses more than one spreading code, it is said to use so-called multi-code transmission.

For variable bit-rate connections, i.e. a connection where the bit-rate varies during the duration of a call, the number of spreading codes actually used by each connection will vary in time and between the different connections. A high bit-rate uses more spreading codes than a lower bit-rate.

One example of a scheme to assign spreading codes to a connection with a variable bit-rate in a radio communication system is the static allocation.

A static allocation means that each connection is, at call set-up, allocated as many spreading codes as is needed to be able to transmit at a requested maximum bit-rate.

This means that a small number of connections with variable bit-rate connection might allocate all available spreading codes even if they do not have to use all of them simultaneous.

Another example of a scheme to assign spreading codes to a connection is the dynamic allocation.

A dynamic allocation means that all connections share a common pool of spreading codes that are continuously redistributed by a base station, according to the instantaneous need of each connection.
Each time the bit-rate at a connection is to be increased the base station has to inform the radio unit what new spreading codes to receive. This will require a significant overhead in the communication between the base station and radio unit.

The US patent US 5 533 013 describes a method and a system for assigning complete orthogonal spreading codes and radio channels in a combined CDMA/TDMA or TDMA/CDMA communication system. Said method comprises the step of assigning an orthogonal spreading code selected from a set of complete orthogonal spreading codes. Said system comprises means for assigning orthogonal spreading codes selected from at least one code set of complete orthogonal spreading codes. If more than one set, the code sets of complete orthogonal spreading codes have been selected so that they are completely orthogonal in relation to each other.

The US patent US 5 452 328 describes a method for assigning disjoint sets of binary spreading-code sequences to different nodes in a multi-node communication network.
Each node in the network is allotted spreading-code sequences which are selected from a family of "almost orthogonal" binary sequences. The patent also describes an apparatus and a method

for generating said family of sequences by combining a first and a second multi-stage shift register.

As will be seen herein, each of the methods disclosed in these patents is of a different construction than the method of the present invention.

The name radio unit includes all portable and non-portable equipment intended for radio communication, like mobile phones, pagers, telex, electronic notebooks and communicators. These equipment's can be used in any type of radio communication system, such as cellular networks, satellite or small local networks.

SUMMARY

The present invention meets problems related to how a forward-link connection is assigned specific spreading codes in a DS-CDMA communication system where only a finite number of orthogonal spreading codes are available.

One problem occurs when the system is using static allocation for variable bit-rate connections. The system may run out of spreading codes even if only a small number of spreading codes are actually used simultaneous. Each connection has allocated the amount of spreading codes that is needed for the maximum bit-rate irrespective of if the maximum bit-rate is needed for only a short time.

Another problem occurs when the system is using dynamic allocation for variable bit-rate connections. A significant overhead in the communication between the base station and the radio unit is needed to inform the radio unit what new spreading codes to receive each time the bit-rate is increased.

In light of the foregoing, a primary object of the present invention is to provide methods and means to assign spreading codes for radio units in a DS-CDMA communication system with variable bit-rate connections.

Another object of the present invention is to provide a large number of available spreading codes which is not limited by the amount of orthogonal spreading codes available in a DS-CDMA communication system.

A further object of the present invention is to avoid re-allocation of spreading codes during the call in a DS-CDMA communication system.

In accordance with a first aspect of the present invention, spreading codes are assigned to forward-link connections from a first set of orthogonal spreading codes as long as there are spreading codes available in the first set. When all spreading codes in the first set is allocated, a second set of orthogonal spreading codes which are non-orthogonal to the spreading codes in the first set is used from which spreading codes are assigned to the forward-link connections. When applicable, more than two sets of spreading codes are used.

According to a second aspect of the present invention, spreading codes assigned to forward-link connection are assigned from two different code sets. A first group of the spreading codes is assigned from the first code set and a second group of the spreading codes is assigned from the second code set. When applicable, more than two sets of spreading codes are used.

The present invention includes methods for assigning spreading codes to variable bit-rate forward-link connections. The methods include the step of assigning spreading codes from a first set

of orthogonal spreading codes. The method also includes the step of assigning spreading codes from a second set of orthogonal spreading codes which are non-orthogonal to the spreading codes in the first set.

According to the first aspect of the present invention, spreading codes are first assigned from the first set of spreading codes. Spreading codes are then assigned from the second code set when all spreading codes in the first code set is allocated. The number of code sets can be extended to more than two code sets.

According to the second aspect of the invention, the spreading codes are assigned from two different code sets.

A first group of spreading codes is assigned from the first code set and a second group of spreading codes is assigned from the second code set. The first group of the spreading codes comprises those codes which are most frequently used. The second group comprises the remaining codes. More than two code sets can be used.

One advantage with the present invention is that the number of simultaneous allocated spreading codes is not hard limited by the size of a code set.

Another advantage is that each connection is allocated a number of spreading codes at call set-up. No further spreading code re-allocation is needed.

BRIEF DESCRIPTION OF THE DRAWINGS

These above mentioned objects and other features of the present invention will become more readily apparent upon reference to the following description when taken in conjunction with the accompanying drawings.

Figure 1 is an illustration of a base station and four radio units in a DS-CDMA communication system.

Figure 2 is an illustration of an example of a set of code sets in accordance with the present invention.

Figure 3 is a first part of a flow chart illustrating a first embodiment of a method in accordance with the present invention.

Figure 4 is a second part of the flow chart in figure 3.

Figure 5 is an illustration of a set of code sets with assigned spreading codes in accordance with the first embodiment in figure 3 and 4.

Figure 6a is a first part of a flow chart illustrating a second embodiment of a method in accordance with the present invention.

Figure 6b is a second part of the flow chart in figure 6a.

Figure 7 is an illustration of four groups of spreading codes.

Figure 8 is an illustration of a set of code sets with assigned spreading codes in accordance with the second embodiment in figure 6a-b.

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention relates to methods for assigning spreading codes to forward-link connections in DS-CDMA communication systems. The forward-link connections are radio connections where the bit-rate can be varied (variable bit-rate) during the duration of a call.

The spreading codes can be assigned at call set-up and e.g. at handover and during set-up of additional services.

Figure 1 shows a base station B and four radio units U1-U4 in a DS-CDMA communication system. Each radio unit U1-U4 has a forward-link connection C1-C4, with a variable bit-rate, between the base station B and the respective unit U1-U4.

When a first forward-link connection C1 between the base station B and the radio unit U1 is to be set up a specified number of spreading codes are assigned to the first forward-link connection C1 by the base station B or by some other part of the communication system. The spreading codes assigned to this forward-link connection C1 can not be assigned to new forward-link connections C2-C4 within the same cell as long as the first forward-link connection C1 is up.

The number of spreading codes which are assigned to each of the connections is determined by the desired bit-rate according to the following:

A connection with a high bit-rate needs more spreading codes than a connection with a low bit-rate.

A connection with multi-code transmission uses several codes in parallel to increase the bit-rate.

Figure 2 shows an example of a set 20 of code sets S1-Sn according to the present invention. A first code set S1 comprises a number of orthogonal spreading codes m_1.
A second code set S2 also comprises a number of orthogonal spreading codes m_2. These spreading codes are orthogonal in relation to each other but non-orthogonal in relation to the spreading codes in the first code set S1.
A third code set S3 also comprises a number of orthogonal spreading codes m_3. These spreading codes are orthogonal in relation to each other but non-orthogonal in relation to the spreading codes in the first and second code set S1 and S2.
The number of code sets n with spreading codes can be more than three.

Figure 3 and 4 show a flow chart of a first embodiment of a method according to the present invention where a number of spreading codes corresponding to a requested bit-rate are assigned to a variable bit-rate forward-link connection C1.

In a step 31a the number of spreading codes needed to transmit at the requested bit-rate between a base station B and a radio unit U1 on the forward-link connection C1 is determined.

In a step 31b the number of available (not assigned) spreading codes in all available code sets is determined. If there are less spreading codes available than the spreading codes needed the method ends, otherwise it continues with a step 32.

In step 32 the number of available (not assigned) spreading codes in a selected first set S1 of orthogonal spreading codes is determined. If there are no available spreading codes in the first set S1 of spreading codes the method continues with a step 35. If there are available spreading codes in the first set S1 of spreading codes the method continues with a step 33.

In step 33 a number of spreading codes, not exceeding the number of spreading codes needed on the forward-link connection C1, are assigned from the first set S1 of spreading codes to the forward-link connection C1.

In a step 34 the number of spreading codes needed is compared with the number of spreading codes assigned from the first set S1 of spreading codes. The method ends if the number of spreading codes needed are equal to the number of spreading codes assigned from the first set S1 of spreading codes, otherwise it continues with a step 35.

In step 35 the number of available spreading codes in a selected second set S2 of orthogonal spreading codes is determined. If there are no available spreading codes in the second set S2 of spreading codes the method continues with a step 38. If there are available spreading codes in the second set S2 of spreading codes the method continues with a step 36.

In step 36 a number of spreading codes, not exceeding the number of spreading codes needed on the forward-link connection C1, are assigned to the forward-link connection C1.

In a step 37 the number of spreading codes needed is compared with the number of spreading codes assigned from the first and second set of spreading codes S1, S2 respectively. The method ends if the number of spreading codes needed are equal to the number of spreading codes assigned from the first and second set of spreading codes S1, S2 respectively, otherwise it continues with step 38.

In step 38, shown in figure 4, the number of code sets is determined. The method continues with a step 39 if the number of code sets is three, otherwise it ends.

In step 39 the number of available spreading codes in a selected third set S3 of orthogonal spreading codes is determined. If there are no available spreading codes in the third set S3 of spreading codes the method continues with a step 42. If there are available spreading codes in the third set S3 of spreading codes the method continues with a step 40.

In step 40 a number of spreading codes, not exceeding the number of spreading codes needed on the forward-link connection C1, are assigned from the third set S3 of spreading codes.

In a step 41 the number of spreading codes needed is compared with the number of spreading codes assigned from the first, second and third set of spreading codes S1, S2, S3 respectively. The method ends if the number of spreading codes needed are equal to the number of spreading codes assigned from the first, second and third set of spreading codes S1, S2, S3 respectively, otherwise it continues with step 42.

In step 42, the number of code sets is determined. If the number of code sets is three the method ends, otherwise it continues with more steps similar to the previous steps 39-42 as long as there are more spreading codes to be assigned and more sets S1-Sn of codes available.

The method according to figure 3 and 4 is repeated each time a new forward-link connection is to be set-up.

Figure 5 shows an illustration of a set 50 of code sets S1-Sn comprising spreading codes according to the first embodiment. The first forward-link connection C1 between the base station B and the radio unit U1, see figure 1, has been assigned a first number of spreading codes x from the first set S1 of spreading codes. A second forward-link connection C2 has been assigned a second number of spreading codes y. A first part $y-k_1$ of the

second number of spreading codes y are taken from the first set S1 of spreading codes and is assigned to the second forward-link connection C2. The first part $y-k_1$ of the second number of spreading codes y comprises at least one complete spreading code. A second part k_1 of the second number of spreading codes y is taken from the second set S2 of spreading codes and is assigned to the second forward-link connection C2. The second part k_1 of the second number of spreading codes y comprises at least one complete spreading code. The number of non-assigned spreading codes in the first set S1 of spreading codes were less than y so more spreading codes where assigned from the second set S2 of spreading codes.

A third forward-link connection C3 has been assigned a third number of spreading codes z from the second set S2 of spreading codes.

A fourth forward-link connection C4 has been assigned a fourth number of spreading codes w. A first part $w-k_2$ of the fourth number of spreading codes w is taken from the second set S2 of spreading codes and is assigned to the fourth forward-link connection C4. The first part $w-k_2$ of the fourth number of spreading codes w comprises at least one complete spreading code. A second part k_2 of the fourth number of spreading codes w is taken from the third set S3 of spreading codes and is assigned to the fourth forward-link connection C4. The second part k_2 of the fourth number of spreading codes w comprises at least one complete spreading code.

Figures 6a-b show a flow chart of a second embodiment of a method according to the present invention where a number of spreading codes corresponding to a requested bit-rate are assigned to a forward-link connection C1 with variable bit-rate.

In a step 61a a total number of spreading codes needed to transmit at the requested bit-rate between the base station B

and a radio unit U1 on the forward-link connection C1 is determined.

In a step 61b the number of available (not assigned) spreading codes in all available code sets is determined. If there are less spreading codes available than the total number of spreading codes needed the method ends, otherwise it continues with a step 62.

In step 62 the total number of spreading codes needed is divided in a first and a second group x_1, x_2 respectively. The number of spreading codes needed in the first group x_1 corresponds to the number of spreading codes which will be most frequently used on the forward-link connection C1. The number of spreading codes needed in the second group x_2 corresponds to the number of spreading codes which will be less frequently used on the forward-link connection C1. Together the first and second group x_1, x_2 respectively will include the total number of spreading codes needed for the forward-link connection C1.

In a step 63 the number of available (not assigned) spreading codes in a selected first set S1 of orthogonal spreading codes is determined. If there are no available spreading codes in the first set S1 of spreading codes the method continues with a step 70, see page 14. If there are available spreading codes in the first set S1 of spreading codes the method continues with a step 64.

In step 64 a number of spreading codes, not exceeding the number of spreading codes needed to the first group x_1, are assigned to the first group of spreading codes x_1 from the first set S1 of spreading codes.

In a step 65 the number of spreading codes needed in the first group x_1 is compared with the number of spreading codes assigned

from the first set S1 of spreading codes. If the number of spreading codes needed in the first group x_1 is equal to the number of spreading codes assigned from the first set S1 of spreading codes the method continues with a step 66 to assign spreading codes to the second group x_2, otherwise it continues with step 70 to assign more spreading codes to the first group x_1.

In step 66, shown in figure 6b, the number of available (not assigned) spreading codes in a selected second set S2 of orthogonal spreading codes is determined. If there are no available spreading codes in the second set S2 of spreading codes the method continues with a step 69. If there are available spreading codes in the second set S2 of spreading codes the method continues with a step 67.

In step 67 a number of spreading codes, not exceeding the number of spreading codes needed to the second group x_2, are assigned to the second group x_2 from the second set S2 of spreading codes.

In a step 68 the number of spreading codes needed in the second group x_2 is compared with the number of spreading codes assigned from the second set S2 of spreading codes. The method ends if the number of spreading codes needed in the second group x_2 is equal to the number of spreading codes assigned from the second set S2 of spreading codes, otherwise it continues with step 69 to assign more spreading codes to the second group x_2.

In step 69, the number of code sets is determined. The method continues with steps similar to the previous steps 63-69 if the number of code sets is more than two, otherwise it ends.

In step 70 the number of available spreading codes in the selected second set S2 of orthogonal spreading codes is determined.
If there are no available spreading codes in the second set S2 of spreading codes the method continues with a step similar to step 69 to search for more code sets. If there are available spreading codes in the second set S2 of spreading codes the method continues with a step where spreading codes is assigned to the first group x_1 from the second code set S2.

The spreading codes to the second group x_2 is then assigned from a third set S3 of spreading codes.

The method according to figures 6a-b continue with steps similar to the previous steps 63-70 as long as there are more spreading codes to be assigned and more sets of codes S1-Sn available.
The method is repeated each time a new forward-link connection with variable bit-rate is to be set-up.

Figure 7 shows an example of four groups of spreading codes G1, G2, G3, G4 respectively assigned to four different variable bit-rate forward-link connections C1-C4. Each group G1, G2, G3, G4 respectively comprises the total number of spreading codes needed in each forward-link connection C1-C4. The total number of spreading codes needed in each forward-link connection C1-C4 is divided in the first and second group of spreading codes x_1, y_1, z_1, w_1 , x_2, y_2, z_2, w_2 respectively, where each group x_1, y_1, z_1, w_1 , x_2, y_2, z_2, w_2 respectively comprises complete spreading codes.

Figure 8 shows an illustration of a set 80 of code sets S1-Sn according to the second embodiment of the method in figure 6. The first forward-link connection C1 with variable bit-rate between the base station B and the radio unit U1, see figure 1, has been assigned spreading codes from the first S1 and second

S2 code set. The first group x_1 of spreading codes has been assigned from the first code set S1 and the second group x_2 of spreading codes has been assigned from the second code set S2.

The second forward-link connection C2 with variable bit-rate between the base station B and the radio unit U2, see figure 1, has been assigned spreading codes from the first S1 and second S2 code set. The first group y_1 of spreading codes has been assigned from the first code set S1 and the second group y_2 of spreading codes has been assigned from the second code set S2.

The third forward-link connection C3 with variable bit-rate between the base station B and the radio unit U3, see figure 1, has been assigned spreading codes from the first S1 and second S2 code set. The first group z_1 of spreading codes has been assigned from the first code set S1 and the second group z_2 of spreading codes has been assigned from the second code set S2.

The fourth forward-link connection C4 with variable bit-rate between the base station B and the radio unit U4, see figure 1, has been assigned spreading codes from the first S1 and third S3 code set. The first group w_1 of spreading codes has been assigned from the first code set S1 and the second group w_2 of spreading codes has been assigned from the third code set S3. There were no non-assigned spreading codes in the second code set S2 left so more spreading codes where assigned from the third code set S3.

The signals which have been coded by short spreading codes in the methods according to the present invention can be scrambled. Signals in a forward-link connection which have been coded by short spreading codes is scrambled by a common (long) Pseudo-Noise code (PN-code). The scrambling randomise the interference between the cells. The scrambling will not affect the orthogonality between the signals in one cell as all signals

uses the same PN-code. The neighbouring cells uses different PN-codes.

CLAIMS

1. A method for assigning spreading codes to a first corresponding forward-link connection (C1) among a plurality of forward-link connections (C1-C4) in a DS-CDMA communication system having a plurality of radio units (U1-U4), comprising the following steps:

a) assigning (33) spreading codes from a selected first set (S1) of orthogonal spreading codes to said first forward-link connection (C1),

c h a r a c t e r i s e d in the further step of:

b) assigning (36) spreading codes from a selected second set (S2) of orthogonal spreading codes to said first forward-link connection (C1) if said first forward-link connection (C1) requires more spreading codes then there are available in said first set (S1) of orthogonal spreading codes, where at least one of said spreading codes of said second set (S2) of orthogonal spreading codes are non-orthogonal to at least one of said spreading codes of said first set (S1) of orthogonal spreading codes.

2. A method as claimed in claim 1, c h a r a c t e r i s e d in that said assigning (33, 36) according to step a)-b) implies assigning said spreading codes to said first forward-link connection (C1) at call set-up.

3. A method as claimed in claim 1 or 2, c h a r a c t e r i s e d in that said assigning (33, 36) according to step a)-b) implies assigning of a number of spreading codes to said first forward-link connection (C1), where said number of spreading codes is determined by a requested maximum bit-rate.

4. A method as claimed in one of claims 1-3, c h a r a c t e r i s e d in that said forward-link connection (C1) is a variable bit-rate forward-link connection (C1).

5. A method as claimed in one of claims 1-4, c h a r a c t e r i s e d in that said DS-CDMA communication system provides multi-code transmission.

6. A method as claimed in one of claims 1-5, c h a r a c t e r i s e d in that said method further comprises the step of:

c) assigning (40) spreading codes from a selected third set (S3) of orthogonal spreading codes to said first forward-link connection (C1), if said first forward-link connection (C1) requires more spreading codes then there are available in said first (S1) and second (S2) set of orthogonal spreading codes, where at least one of said spreading codes of said third set (S3) of orthogonal spreading codes are non-orthogonal to at least one of said spreading codes of said first (S1) and second (S2) set of orthogonal spreading codes.

7. A method for assigning spreading codes to corresponding forward-link connections (C1-C4) in a DS-CDMA communication system having a plurality of radio units (U1-U4), comprising the following steps:

a) assigning (33) a first number of spreading codes (x) from a first set (S1) of orthogonal spreading codes to a first forward-link connection (C1);

c h a r a c t e r i s e d in the further step of:

b) assigning (33) a first part $(y-k_1)$ of complete spreading codes of a second number of spreading codes (y) from said first set (S1) of spreading codes to a second forward-link connection (C2);

c) assigning (36) a second part of complete spreading codes (k_1) of said second number of spreading codes (y) from a second set (S2) of orthogonal spreading codes to said second forward-link connection (C2), where at least one of said spreading codes of said second set (S2) are non-orthogonal to at least one of said spreading codes of said first set (S1).

8. A method for assigning a number of spreading codes to a first corresponding forward-link connection (C1) among a plurality of forward-link connections (C1-C4) in a DS-CDMA communication system having a plurality of radio units (U1-U4),
c h a r a c t e r i s e d in the following steps:

a) assigning (64) a first group (x_1) of complete spreading codes to said first forward-link connection (C1) from a selected first set (S1) of orthogonal spreading codes;

b) assigning (67) a second group (x_2) of complete spreading codes to said first forward-link connection (C1) from a selected second set (S2) of orthogonal spreading codes, where at least one of said spreading codes of said second set (S2) are non-orthogonal to at least one of said spreading codes of said first set (S1), and where said first (x_1) and second (x_2) group of spreading codes includes said number of spreading codes needed for said forward-link connection (C1).

9. A method as claimed in claim 8,
c h a r a c t e r i s e d in that said assigning (64, 67) according to step a)-b) implies assigning the spreading codes to said first forward-link connection (C1) at call set-up.

10. A method as claimed in claim 8 or 9,
c h a r a c t e r i s e d in that said number of spreading codes needed to said first forward-link connection (C1) is determined by a requested maximum bit-rate.

11. A method as claimed in one of claims 8-10,

c h a r a c t e r i s e d in that said forward-link connection (C1) is a variable bit-rate forward-link connection (C1).

12. A method as claimed in one of claims 8-11, c h a r a c t e r i s e d in that said DS-CDMA communication system provides multi-code transmission.

13. A method for assigning a total number of spreading codes to corresponding forward-link connections (C1-C4) with variable bit-rate in a DS-CDMA communication system having a plurality of radio units (U1-U4), c h a r a c t e r i s e d in the following steps:

a) assigning (64) a first group (x_1) of complete spreading codes to a first forward-link connection (C1) from a first set (S1) of orthogonal spreading codes;

b) assigning (64) a first group (y_1) of complete spreading codes to a second forward-link connection (C2) from said first set (S1) of orthogonal spreading codes;

c) assigning (67) a second group (x_2) of complete spreading codes to said first forward-link connection (C1) from a second set (S2) of orthogonal spreading codes, where at least one of said spreading codes of said second set (S2) are non-orthogonal to at least one of said spreading codes of said first set (S1), and where said first (x_1) and second (x_2) group of spreading codes to said first forward-link connection (C1) includes the total number of spreading codes needed for said first forward-link connection (C1);

d) assigning (67) a second group (y_2) of complete spreading codes to said second forward-link connection (C2) from said second set (S2) of orthogonal spreading codes, where said first (y_1) and second (y_2) group of spreading codes to said second forward-link connection (C2) includes the total number of spreading codes needed for said second forward-link connection (C2).

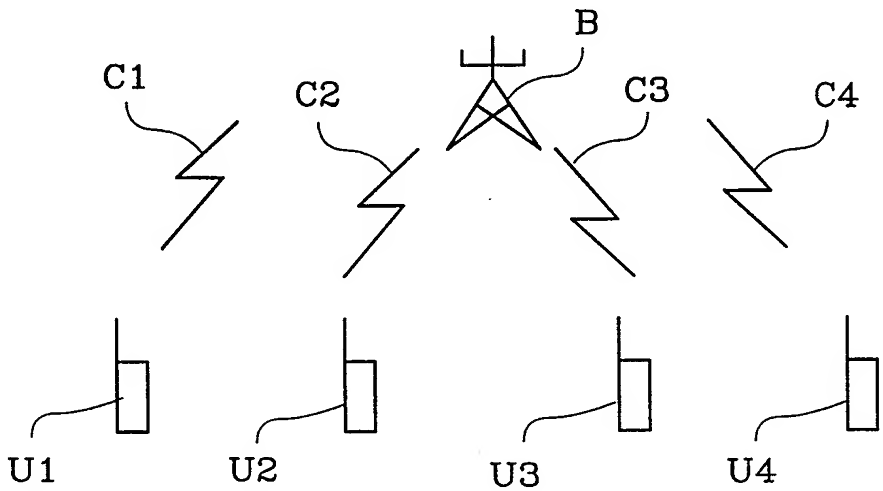


Fig. 1

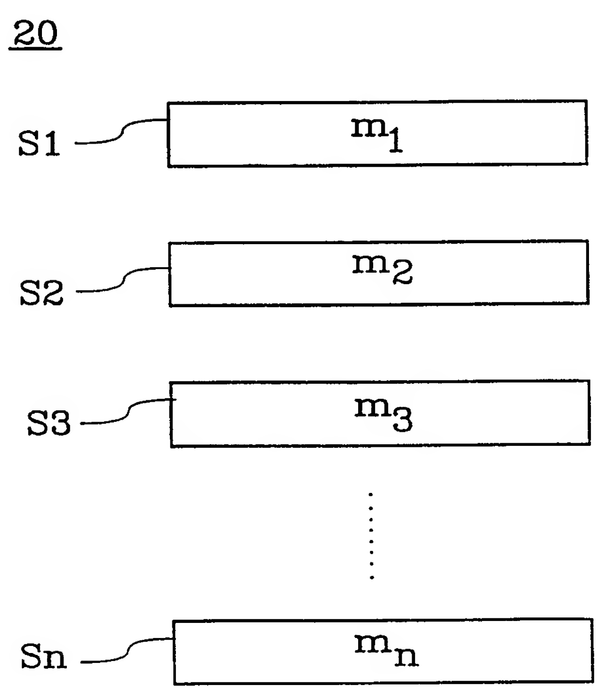
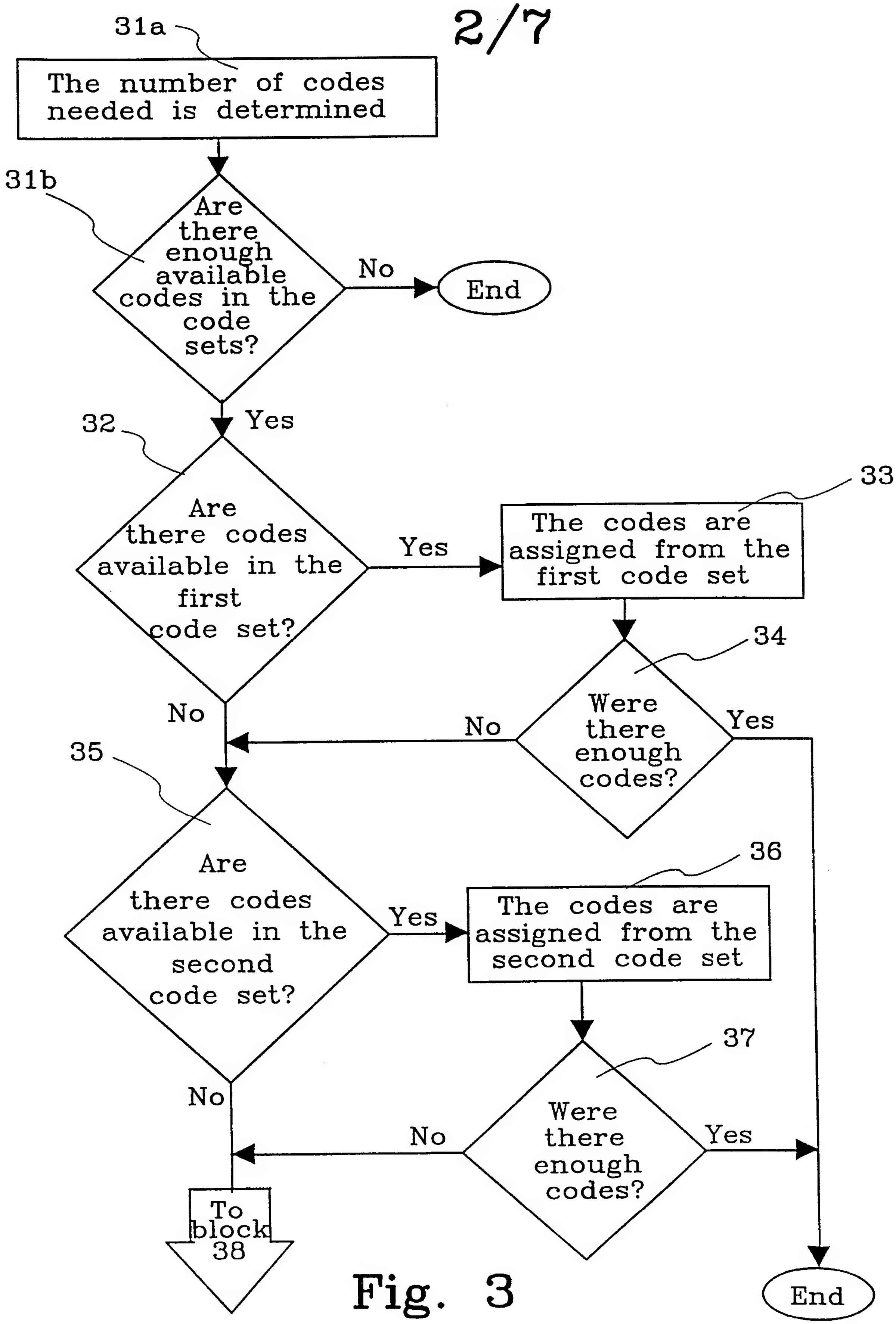


Fig. 2



31a
The number of codes needed is determined
31b
Are there enough available codes in the code sets?
No
End
Yes
32
Are there codes available in the first code set?
Yes
33
The codes are assigned from the first code set
34
Were there enough codes?
No
Yes
No
35
Are there codes available in the second code set?
Yes
36
The codes are assigned from the second code set
37
Were there enough codes?
No
Yes
No
To block 38
End

Fig. 3

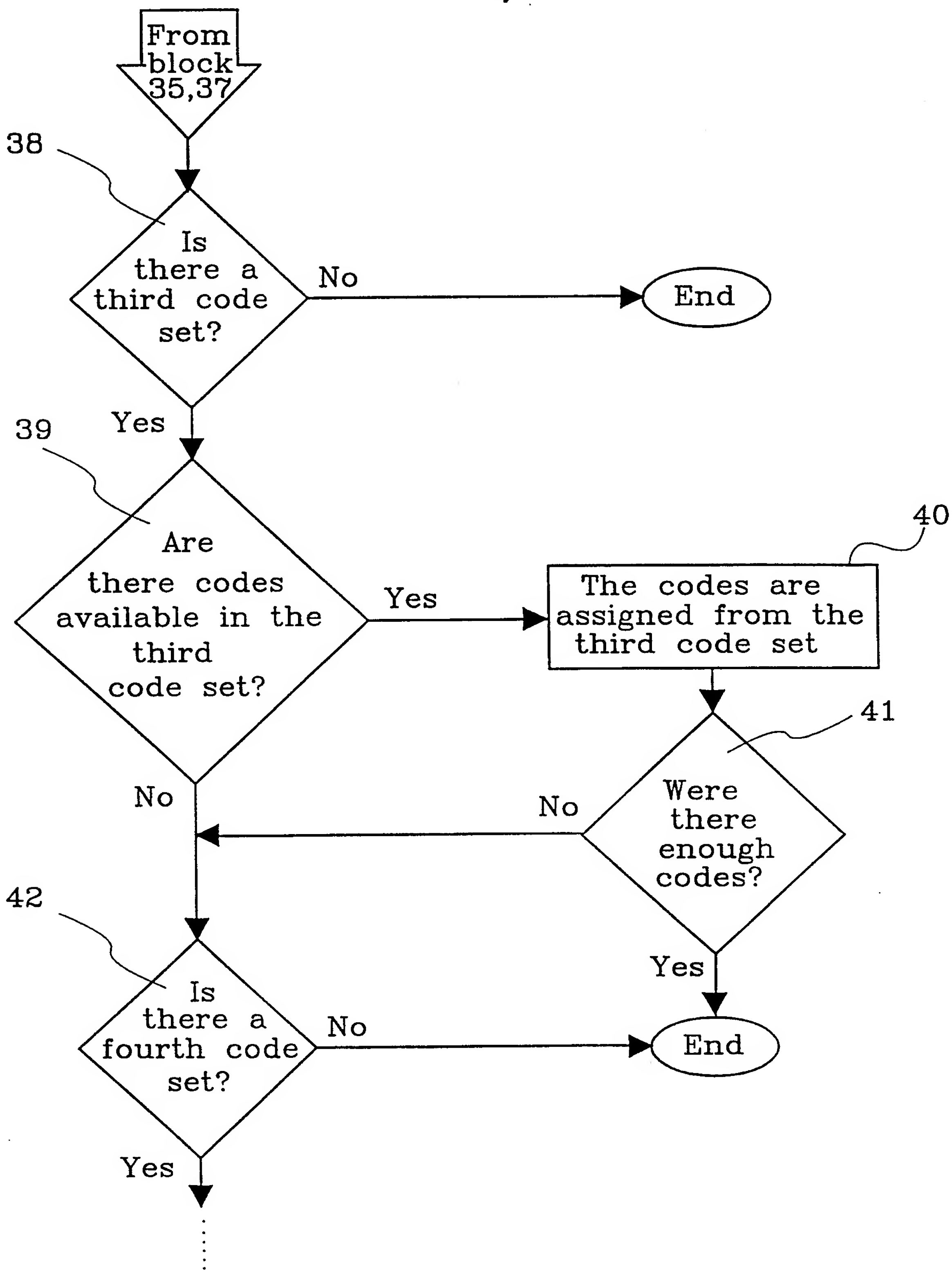

From block 35,37
38
Is there a third code set?
No
End
Yes
39
Are there codes available in the third code set?
Yes
40
The codes are assigned from the third code set
41
Were there enough codes?
No
No
42
Yes
Is there a fourth code set?
No
End
Yes

Fig. 4

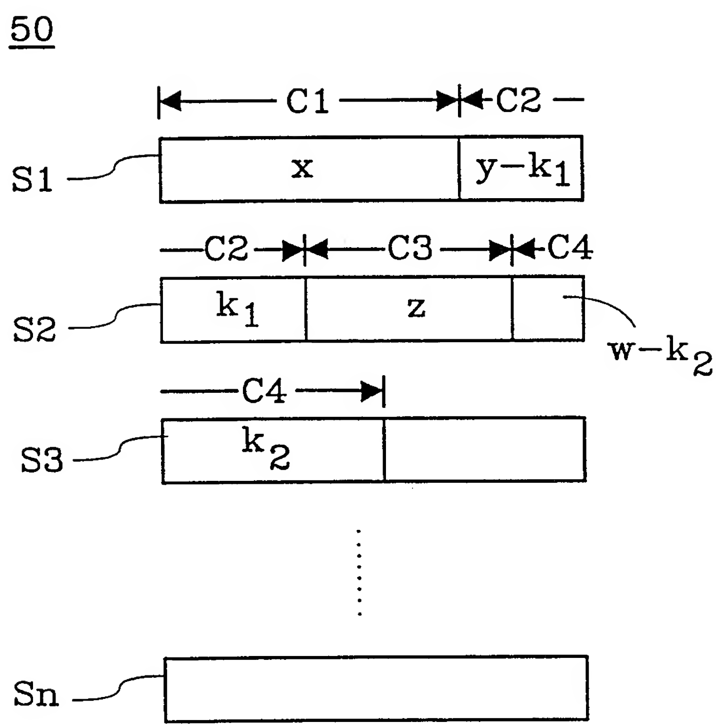


Fig. 5

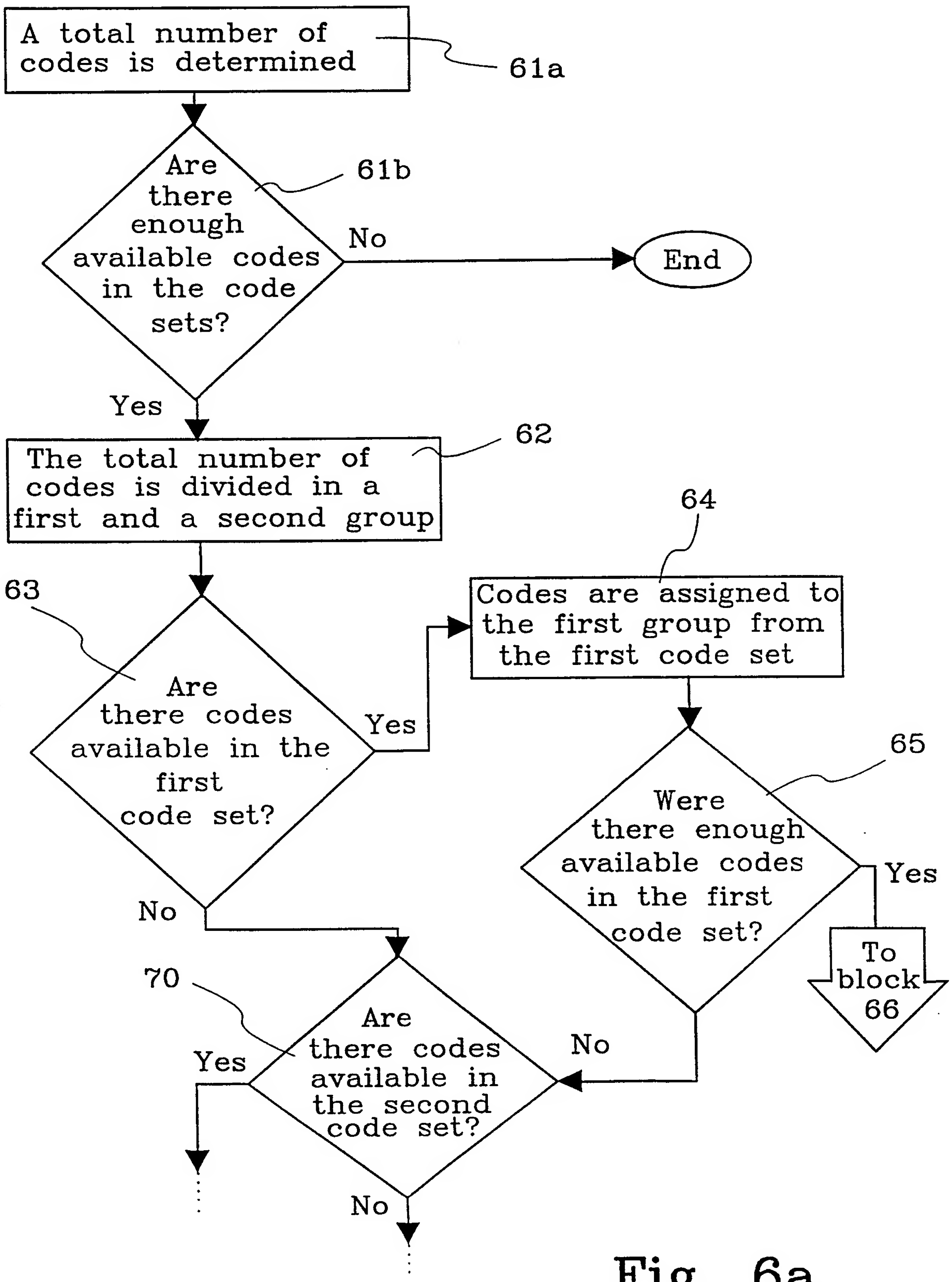

A total number of codes is determined
61a
Are there enough available codes in the code sets?
61b
No
End
Yes
The total number of codes is divided in a first and a second group
62
64
63
Codes are assigned to the first group from the first code set
Are there codes available in the first code set?
Yes
65
Were there enough available codes in the first code set?
Yes
To block 66
No
70
Are there codes available in the second code set?
Yes
No
No

Fig. 6a

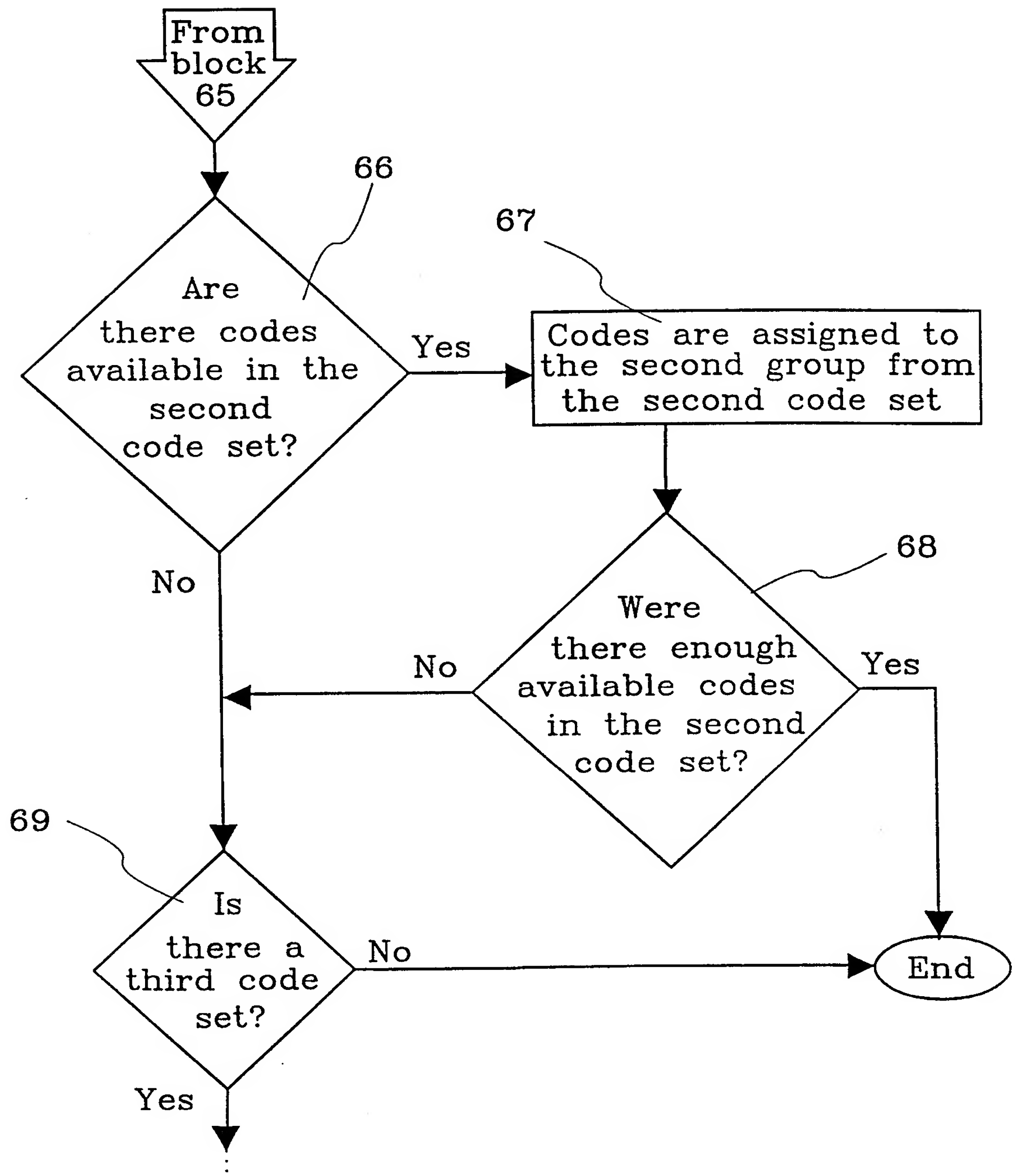

From block 65
66
Are there codes available in the second code set?
Yes
67
Codes are assigned to the second group from the second code set
No
68
Were there enough available codes in the second code set?
No
Yes
69
Is there a third code set?
No
End
Yes

Fig. 6b

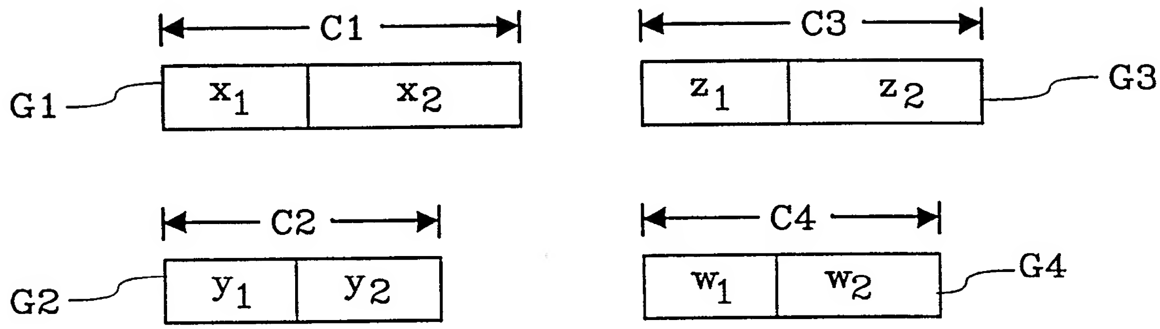

C1
C3
G1
x_1
x_2
z_1
z_2
G3
C2
C4
G2
y_1
y_2
w_1
w_2
G4

Fig. 7

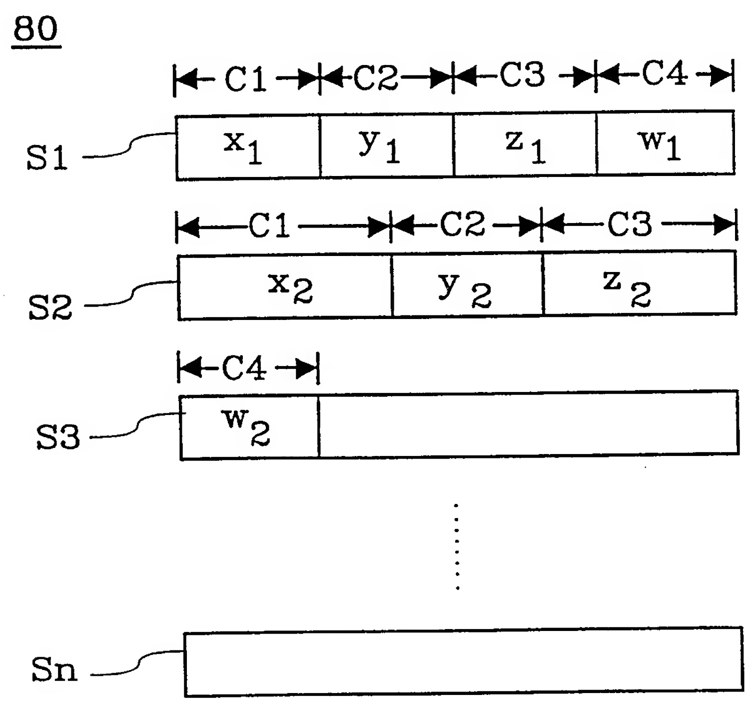

80
C1
C2
C3
C4
S1
x_1
y_1
z_1
w_1
C1
C2
C3
S2
x_2
y_2
z_2
C4
S3
w_2
Sn

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01541

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 7/26
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B, H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9715985 A1 (NOKIA MOBILE PHONES LTD.), 1 May 1997 (01.05.97), page 7, line 13 - page 9, line 6; page 9, line 28 - page 10, line 20; page 14, line 1 - line 34	1-13
	--	
X	International Conference on Communications Conference record ..., Volume 2, June 1995, (Seattle, Washington, USA), Mo-Han Fong et al, "CONCATENATED ORTHOGONAL/PN SPREADING SCHEME FOR CELLULAR DS-CDMA SYSTEMS WITH INTEGRATED TRAFFIC Page 905-909" page 908	1-13
	--	
A	WO 9503652 A1 (QUALCOMM INCORPORATED), 2 February 1995 (02.02.95), page 13, line 11 - page 17, line 37	1-13
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 January 1999	01 -02- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jaana Raivio Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01541

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9523459 A1 (MOTOROLA INC.), 31 August 1995 (31.08.95), see whole document --	1-13
A	US 5210770 A (BART F. RICE), 11 May 1993 (11.05.93), see whole document -- --------	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

21/12/98

International application No.
PCT/SE 98/01541

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9715985 A1	01/05/97	AU 7302296 A	15/05/97
		EP 0857376 A	12/08/98
		FI 955113 A	27/04/97
WO 9503652 A1	02/02/95	AU 7368294 A	20/02/95
		IL 110373 D	00/00/00
		US 5751761 A	12/05/98
		ZA 9405260 A	27/02/95
WO 9523459 A1	31/08/95	CA 2158356 A	31/08/95
		EP 0705500 A	10/04/96
		FI 955063 A	24/10/95
		JP 8509591 T	08/10/96
		US 5515396 A	07/05/96
US 5210770 A	11/05/93	US 5267271 A	30/11/93
		US 5452328 A	19/09/95
		US 5815526 A	29/09/98